

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1. (currently amended) An apparatus for measuring the composition at least one parameter of a mixture flowing through a pipe, said apparatus comprising:

an ultrasonic sensor apparatus a pair of ultrasonic transducers disposed axially along the pipe that transmits an ultrasonic signal through the mixture and receives the ultrasonic signal, to provide a measured signal indicative of the transit time of the ultrasonic signal through the mixture, wherein the mixture includes particles suspended within a fluid; for measuring the transit time of an ultrasonic signal to propagate from one ultrasonic transducer to the other ultrasonic transducer; and

a processor, responsive to said measured transit time signal, that determines the speed of sound propagating through the mixture and, responsive to the speed of sound, that determines, which provides an output signal indicative of the composition at least one parameter of the mixture flowing through the pipe using a dispersion model.

2. (canceled)

3. (canceled)

4. (currently amended) The apparatus of claim 1, wherein the apparatus is a probe wherein the pipe comprises a tube having an open input end and open output end for receiving the mixture.

5. (currently amended) The apparatus of claim 1, wherein the ~~frequency~~ wavelength of the ultrasonic signal is ~~sufficiently low to minimize scatter from particle/liquid~~ less than the length scale of the particles within the mixture.

6. (canceled)

7. (canceled)

8. (currently amended) The apparatus of claim 1, wherein the ~~pair of~~ ultrasonic sensor apparatus ~~transducers~~ includes a ~~plurality of~~ at least three ultrasonic transducers disposed axially along the pipe to determine the transit time ~~using the sing-around method~~.

9. (new) The apparatus of claim 1, wherein the wavelength of the ultrasonic signal is orders of magnitude greater than the length scale of the particles within the mixture.

10. (new) The apparatus of claim 1, wherein the ultrasonic sensor apparatus comprises a first ultrasonic transducer disposed at an axial location along the pipe to transmit the ultrasonic signal into the mixture; and a second ultrasonic transducer disposed at an axial location along the pipe to receive the ultrasonic signal from the ultrasonic transducer.

11. (new) The apparatus of claim 10, wherein the first ultrasonic transducer is axially spaced from the second ultrasonic transducer along the pipe.

12. (new) The apparatus of claim 1, wherein the mixture is liquid droplets suspended in gas.

13. (new) The apparatus of claim 1, wherein the mixture is solid particles suspend in a fluid.

14. (new) The apparatus of claim 1 wherein the dispersion model is empirically derived.

15. (new) The apparatus of claim 1 wherein the dispersion model is numerically derived.

16. (new) The apparatus of claim 1 wherein the dispersion model is:

$$a_{mix}(\omega) = a_f \sqrt{\frac{1}{1 + \frac{\phi_p \rho_p}{\rho_f \left(1 + \omega^2 \frac{\rho_p^2 v_p^2}{K^2} \right)}}$$

wherein a_{mix} is the speed of sound propagating through the mixture, a_f is the speed of sound propagating through the gas, K is a proportionality constant, ω is frequency in rad/sec, ϕ_p is the volumetric phase fraction of the liquid droplets, ρ_p is the density of the liquid droplets, v_p is the volume of individual liquid droplets, and ρ_f is the density of the gas.

17. (new) The apparatus of claim 1 wherein the composition of the mixture includes the phase fraction of the mixture.

18. (new) The apparatus of claim 1 wherein the composition of the mixture includes the size of the particles.

19. (new) The apparatus of claim 1 wherein the processor compares at least a transitional frequency range of the dispersion model to determine the average size of the particles in the mixture.

20. (new) The apparatus of claim 1 wherein the processor compares at least one of the lower frequency range and the transitional frequency range of the dispersion model to determine the phase fraction of the mixture.

21. (new) The apparatus of claim 1 wherein the processor determines of the composition of the mixture by determining the speed of sound propagating through the mixture as a function of frequency to characterize dispersion properties of the mixture and comparing the dispersion properties of the mixture to a dispersion model of the mixture.

22. (new) A method for measuring the composition of a mixture in a pipe, said method comprising:

measuring the transit time of an ultrasonic signal propagating through the mixture, wherein the mixture includes particles suspended within a fluid; and

determining the composition of the mixture by determining the speed of sound propagating through the mixture in response to the measured transit time, and using a dispersion model.

23. (new) The method of claim 22 wherein the determining of the composition of the mixture includes determining the speed of sound propagating through the mixture as a function of frequency to characterize dispersion properties of the mixture and comparing the dispersion properties of the mixture to a dispersion model of the mixture.

24. (new) The method of claim 22 further includes comparing at least a transitional frequency range of the dispersion model to determine the average size of the particles in the mixture.

25. (new) The method of claim 22 further includes comparing at least one of the lower frequency range and the transitional frequency range of the dispersion model to determine the phase fraction of the mixture.